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The Burden of Cancer in the Elderly

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I. INTRODUCTION

In 1997, it was estimated that a total of 1,257,800 new cases of invasive cancer would be diagnosed that year in the United States (1). This estimate includes carcinoma in situ of the bladder but excludes more than 900,000 cases of basal and squamous cell skin cancers, 36,400 cases of carcinoma in situ of the breast, and 20,100 cases of melanoma carcinoma in situ. The majority of these cancers occur at three sites. In men, over 55% of new cases are due to cancers of the prostate (32%), lung and bronchus (15%), and colon and rectum (10%). In women, over 50% of new cases are due to cancers of the breast (30%), lung and bronchus (13%), and colon and rectum (11%).

II. TRENDS IN CANCER

Between 1973 and 1994, the cancer incidence rate in men rose 33% for all cancers combined, 3% for lung cancer, and 110% for prostate cancer (1). Among women, the incidence rate increased 13% for all cancers combined, 122% for lung cancer, and 23% for breast cancer. Of the three most common cancers, only the colorectal cancer incidence rate declined overall by 5% for both sexes during this period. The risk of developing most cancers increases with advancing age. Sixty-three percent

of all new cancers in 1990 occurred in the population aged 65 years and older (2). The population of the United States age 65 years and older is projected to increase from 12.5% in 1990, to 13.3% by year 2010, to 20.1% in the year 2030 (3), due in large part to the impact of the Baby Boom generation. The burden of cancer will likewise increase as more people live longer.

In the United States, cancer is the second most frequent cause of death, accounting in 1993 for more than 500,000 deaths (23%) and following only deaths due to heart disease (4). Cancer was the second most frequent cause of death among both males and females overall and at all ages except among males aged 15–34 years, when it fell to fifth, and among females aged 35–74 years, when it was the leading cause of death (Table 1). The most frequent cause of death due to cancer was lung cancer, followed by prostate cancer among males and breast cancer among females, with colorectal cancer third and pancreas cancer fourth among both sexes (Table 2). However, the most common cancers varied by age group. At young ages, leukemia, brain cancer, and non-Hodgkin's lymphoma predominated. At middle ages, breast cancer was the leading cause among women, with lung and colorectal cancers gaining in importance. At ages 55 years and older, the patterns resembled those seen overall. The numbers of deaths due to cancer annually rose from less than 2000 among those under age 15 years to more than 200,000 at ages 75 years and older.

In this chapter, we will draw upon descriptive data available from several sources. Much of the incidence and survival data derive from information regarding primary cancer diagnosed among residents of nine areas of the United States participating in the Surveillance, Epidemiology, and End Results (SEER) program, supported by contracts let by the National Cancer Institute, and population estimates based on data from the Census Bureau (1). The areas include the states of Connecticut, Iowa, Utah, New Mexico, and Hawaii and the metropolitan areas of Detroit, Atlanta, San Francisco–Oakland, and Seattle–Puget Sound, where quality population-based registries have existed for several decades. Specific data on racial/ethnic population subgroups are from SEER (5). Mortality data for the United States were based on death certificate information provided by the National Center for Health Statistics. Published sources were used to evaluate the international variation in mortality among the elderly (6).

The number of cases of cancer, excluding superficial skin cancers, diagnosed in the United States rose 56% from 1975 to 1990 to more than one million per year, and the number of deaths due to cancer rose 40% (Table 3a). These increases were due to several factors. The first is the growth in the population size, which increased 15%. Thus, the crude incidence rate per 100,000 population rose 36% and the crude mortality rate increased 21%. Rates for most cancers rise with age. As mortality due to other causes, notably cardiovascular disease, has declined, people have been living longer and shifting the age distribution toward older ages. A technique called age-adjustment accounts for these changes, permitting comparison of rates as if the population distribution were the same. Comparison of the age-adjusted rates reveals

Table 1 Reported Deaths for the Five Leading Causes of Death by Age and Sex, United States, 1993

Rank	All ages		Ages 0-14		Ages 15-34		Ages 35-54		Ages 55-74		Ages 75+	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1	All causes	All causes	All causes	All causes	All causes	All causes	All causes	All causes	All causes	All causes	All causes	All causes
	1,161,797	1,106,756	9799	6525	70,593	24,535	149,843	78,010	426,512	302,888	486,337	680,138
	Heart diseases 367,479	Heart diseases 375,981	Accidents 3792	Accidents 2264	Accidents 21,475	Accidents 6513	Heart diseases 33,768	Cancer 30,345	Heart diseases 146,359	Cancer 111,937	Heart diseases 183,642	Heart diseases 278,010
2	Cancer	Cancer	Cancer	Cancer	Homicide	Cancer	Cancer	Heart diseases	Cancer	Heart diseases	Cancer	Cancer
	279,375	250,529	922	689	12,892	3308	28,782	12,032	142,057	83,787	104,037	104,203
3	Accidents	Cerebro-vascular diseases	Homicide	Congenital anomalies	HIV infection	Homicide	HIV infection	Accidents	Chronic obstructive pulmonary diseases	Chronic obstructive pulmonary diseases	Cerebro-vascular diseases	Cerebro-vascular diseases
	60,117	91,060	682	637	10,040	2810	19,670	5182	22,936	19,003	36,047	70,193
4	Cerebro-vascular diseases	Chronic obstructive pulmonary diseases	Congenital anomalies	Homicide	Suicide	HIV infection	Accidents	Cerebro-vascular diseases	Cerebro-vascular diseases	Chronic obstructive pulmonary diseases	Chronic obstructive pulmonary diseases	Pneumonia and influenza
	59,048	46,706	652	438	9337	1868	16,102	3469	18,182	16,754	29,339	36,895
5	Chronic obstructive pulmonary diseases	Pneumonia and influenza	Heart diseases	Heart diseases	Cancer	Suicide	Suicide	HIV infection	Diabetes mellitus	Diabetes mellitus	Pneumonia and influenza	Chronic obstructive pulmonary diseases
	54,371	44,824	313	286	3509	1819	7976	2746	10,797	11,665	26,135	25,818

HIV, human immunodeficiency virus.

Source: Ref. 4: based on data from Vital Statistics of the United States, 1996.

Table 2 Reported Deaths for the Five Leading Cancers by Age and Sex, United States, 1993

Rank	Age					
	All ages	Under 15	15-34	35-54	55-74	75+
Males	All cancers	All cancers	All cancers	All cancers	All cancers	All cancers
1	279,375 Lung and bronchus	978 Leukemia	3509 Leukemia	28,782 Lung and bronchus	142,057 Lung and bronchus	104,037 Lung and bronchus
2	92,493 Prostate	359 Brain and ONS	645 Non-Hodgkin's lymphoma	8771 Colon and rectum	55,421 Colon and rectum	28,122 Prostate
3	34,865 Colon and rectum	255 Endocrine system	477 Brain and ONS	2508 Non-Hodgkin's lymphoma	13,689 Prostate	22,465 Colon and rectum
4	28,199 Pancreas	113 Non-Hodgkin's lymphoma	458 Colon and rectum	1699 Brain and ONS	12,051 Pancreas	11,787 Pancreas
5	12,669 Leukemia	63 Soft tissue	209 Hodgkin's disease	1542 Pancreas	6678 Esophagus	4580 Leukemia
Females	All cancers	All cancers	All cancers	All cancers	All cancers	All cancers
1	250,529 Lung and bronchus	721 Leukemia	3308 Breast	30,345 Breast	111,937 Lung and bronchus	104,203 Lung and bronchus
2	56,234 Breast	238 Brain and ONS	560 Leukemia	9279 Lung and bronchus	31,803 Breast	18,802 Colon and rectum
3	43,555 Colon and rectum	205 Endocrine system	441 Brain and ONS	5501 Colon and rectum	18,937 Colon and rectum	16,137 Breast
4	29,206 Pancreas	74 Bones and joints	326 Cervix uteri	2064 Ovary	10,861 Ovary	14,778 Pancreas
5	13,776 Ovary	44 Soft tissue	323 Non-Hodgkin's lymphoma	1823 Cervix uteri	6159 Pancreas	6909 Non-Hodgkin's lymphoma
	12,870	37	214	1623	5933	4854

ONS, other nervous system.

Note: All cancers category excludes basal and squamous cell skin cancers and in situ carcinomas except bladder.

Source: Ref. 4; based on data from Vital Statistics of the United States, 1996.

Table 3a Trends in Total Cancers in the United States, 1975–1990, All Ages

	1975	1990	% Change
Number of cases	665,000	1,040,000	56.4
Number of deaths	365,000	510,000	39.7
Population	215,467,000	248,710,000	15.4
Crude incidence	308.6	418.2	35.5
Crude mortality	169.4	205.1	21.1
Age-adjusted incidence	332.4	394.1	18.6
Age-adjusted mortality	162.3	174.0	7.2

Rates per 100,000; age-adjusted using 1970 U.S. population standard.

Source: unpublished data from the SEER program.

that incidence and mortality rose a more modest 19% and 7%, respectively, which are better reflections of changes in risk.

In 1990, a total of 650,000 cases of cancer were diagnosed among the elderly aged 65 years and older, accounting for 62.5% of the 1,040,000 total cancer cases diagnosed. More than half of the cancers occurring at ages 65 and older were diagnosed among males (Table 3b). By ages 80 years and older, more cases were diagnosed among females, largely due to females having a greater life expectancy than males (2). The number of incident cancers among the elderly is projected to increase among males from 344,200 in 1990 to 905,600 in 2030, or by more than 500,000 (163%), and among females from 305,800 to 626,900, by more than 300,000 (105%), respectively. Among those aged 80 and older, the projected numerical increases are smaller, but the proportional increases are larger: 213% among males and 127% among females. It is projected that the number of incident cancers in elderly men in the U.S. population will increase faster than in women over the next few decades, owing to a faster increase in men's life expectancy (2,7). This projected

Table 3b Projected Numbers of Incident Cancers for U.S. Men and Women Aged 65 Years and Over and Aged 80 Years and Over

Year	Aged 65 years and older		Aged 80 years and older	
	Males	Females	Males	Females
1990	344,200	305,800	82,600	92,700
2000	407,100	341,500	112,300	119,300
2010	477,300	377,300	145,400	142,200
2020	660,800	484,200	168,800	152,200
2030	905,600	626,900	258,900	210,100

Note: Only invasive cancers are included except for in situ bladder tumors.

Source: Ref. 2.

change in the pattern of cancer distribution in elderly men and women is largely unrecognized, but it will be of increasing importance to clinicians, researchers, and health care administrators in planning future cancer care and research interventions, as well as health policy and public health campaigns for the elderly.

The incidence of all cancers combined among the elderly aged 65–84 years increased 33% from 2337 per 100,000 person-years during 1975–1979 to 3114 during 1990–1994 among males and 24% from 1307 to 1625 among females (Fig. 1). Total cancer mortality rose less rapidly, from 1283 to 1367 and from 671 to 794, or 7% and 18% among males and females, respectively. Among elderly males, incidence rates for prostate cancer rose most rapidly, more than doubling over the time period shown (Fig. 2), with the most marked increase occurring between 1985 and 1994, a period during which many subclinical cases of prostate cancer were diagnosed based on prostate-specific antigen (PSA) screening along with digital rectal examination (8–12). Rates also increased substantially for kidney cancer and the lymphomas, due in part to improved diagnoses. The rise in kidney cancer incidence is related to smoking (13–15). The rising lymphoma incidence may be related to occupational exposures to pesticides or solvents, possibly to hair dyes, and to acquired immunodeficiency syndrome (AIDS), particularly among young and middle-aged men (16, 17). Recent epidemiologic leads suggest that the lymphoma risk may be associated with diets that are high in animal protein and fat and low in fruits and vegetables; a prior history of blood transfusions may also increase the risk of lymphomas (18). Notably, the lung cancer incidence has not continued to increase among males in recent years as in earlier periods. This leveling off reflects the impact of a 54% decline in smoking prevalence since 1965, due in large part to successful smoking prevention and cessation public health campaigns. Colorectal cancer peaked during the late 1980s, and rates for stomach and oral cavity cancers have declined.

Among elderly females, the most rapid increases in both incidence and mortality were for lung cancer (Fig. 3). Initiation of smoking in women lagged some 25–30 years behind men. Between 1975 and 1994, the lung cancer rates in women rose faster than in men, whose peak changes had occurred earlier (19). In the early 1990s, lung cancer surpassed colorectal cancer as the second most frequent cancer among females. Breast cancer rates rose significantly until the 1990s with a more modest rise in rates since that time. As among males, incidence rates for lymphomas and kidney cancer also increased substantially. Rates declined notably for stomach and cervix uteri cancers. Among both males and females, cancer-specific mortality rates were lower than the corresponding incidence rates. Of note, in 1985, the lung cancer mortality rate for women aged 65–84 years surpassed the breast cancer mortality rate. In comparison, this lung to breast cancer mortality rate crossover point occurred for all women some 2 years later in 1987; and it was reached some 4 years later in 1989 for all black women (1).

The risk of dying from cancer generally increases exponentially with age (Fig. 4). Based on U.S. mortality data for 1970–1994, rates for all cancers combined increased linearly starting around age 20 years until about age 60, after which the

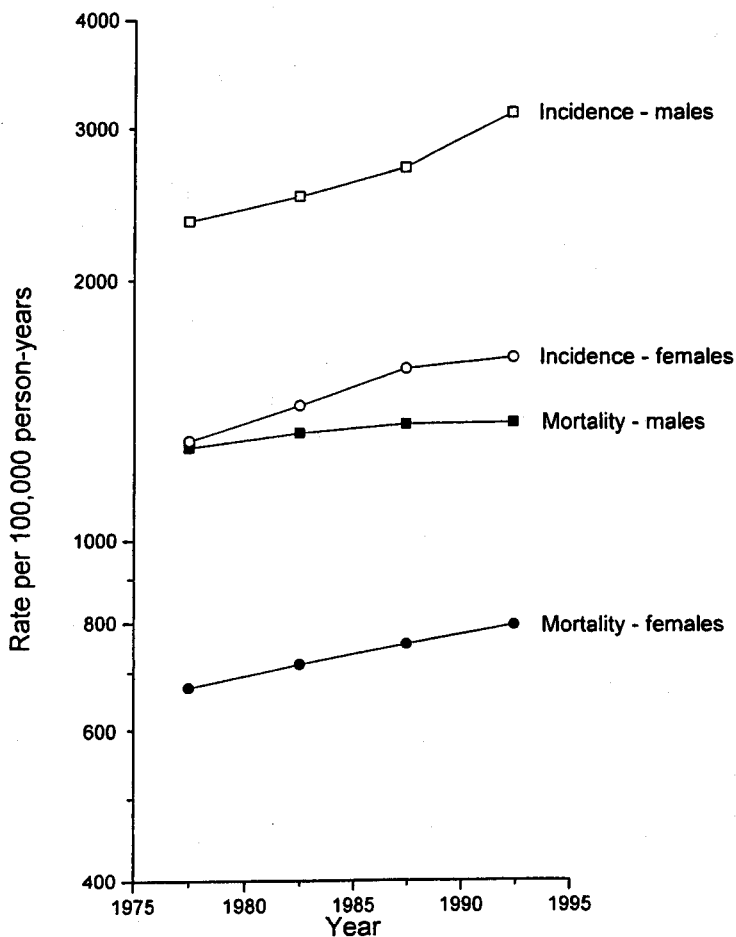


Figure 1 Trends in age-adjusted (1970 U.S. standard) SEER incidence and U.S. mortality for all cancers combined among the elderly aged 65–84 years by sex, 1975–1979 to 1990–1994.

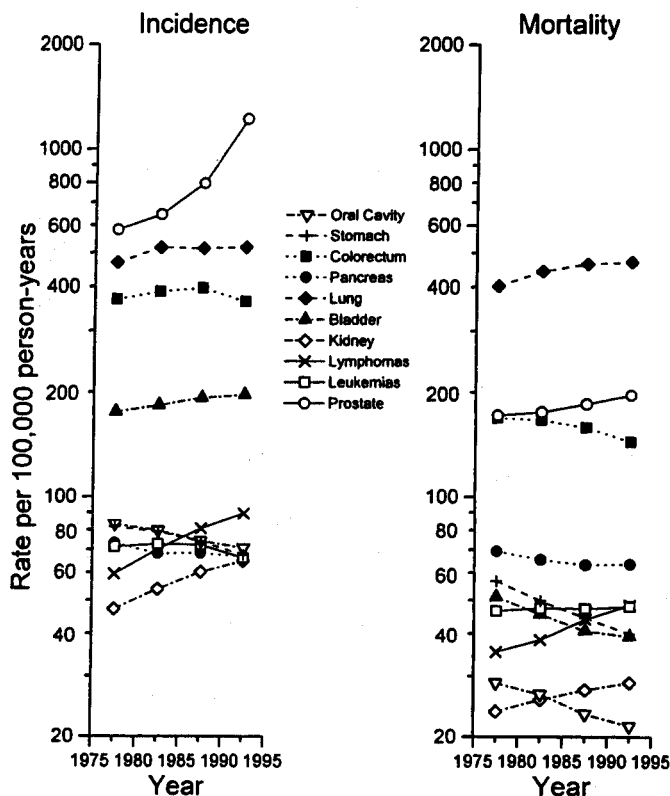


Figure 2 Trends in age-adjusted (1970 U.S. standard) SEER incidence and U.S. mortality for selected cancers among elderly males aged 65–84 years, 1975–1979 to 1990–1994.

increases were less rapid. Higher rates among males than females were most evident at ages 60 and older. This pattern was repeated for many of the specific forms of cancer, although there were exceptions. For lung cancer, the male excess was most pronounced at ages 40 years and older, with smaller differences at younger ages. Consistently higher rates among blacks than whites were evident for esophageal, stomach, cervix uteri, and prostate cancers, whereas rates among whites were notably higher for melanoma of the skin and corpus uteri cancer. Rates among young people generally were quite low, although bimodal curves were apparent for cancers of the kidney and brain and for leukemia.

At current rates, the probability at birth of ever developing cancer is 47%, or almost one out of two for males and 38%, or more than one out of three, for females (Table 4). At birth, the probability of dying of cancer is more than one out of five. By age 60, the probability of eventually developing cancer rises to 48% for males

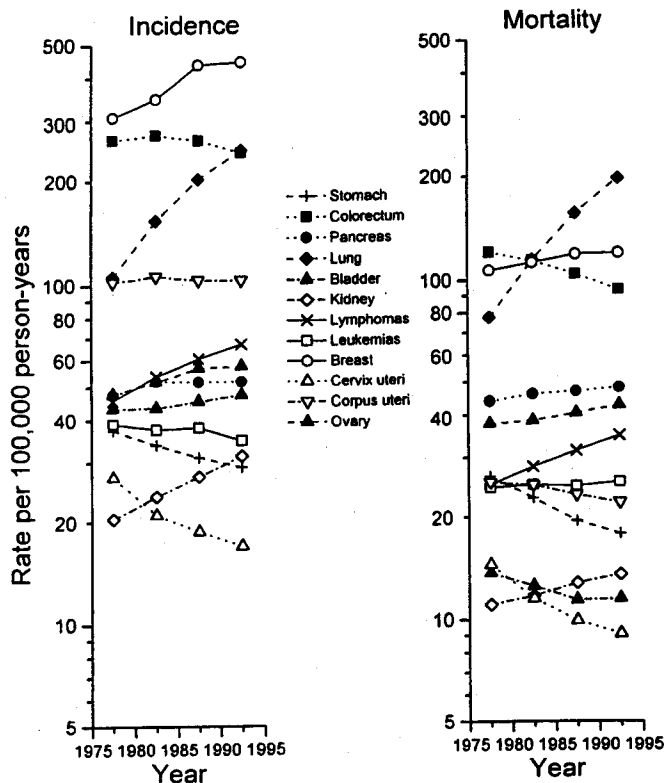


Figure 3 Trends in age-adjusted (1970 U.S. standard) SEER incidence and U.S. mortality for selected cancers among elderly females aged 65–84 years, 1975–1979 to 1990–1994.

but falls to 33% for females. A male at age 60 years has a 21% chance of being diagnosed with prostate cancer, 9% with lung cancer, and 6% with colorectal cancer during his remaining years. A 60-year-old female has almost a 10% risk of breast cancer, 6% of colorectal cancer, and 5% of lung cancer during her remaining lifetime. At current rates, 7% of males will die of lung cancer, 4% of prostate cancer, and 3% of colorectal cancer. More than 4% of females will die of lung cancer and 3% each due to breast or colorectal cancer.

There is considerable variation in cancer incidence and mortality rates according to racial/ethnic group (Fig. 5) (5).¹ The racial categories of Alaska Native,

¹ SEER data are used to show the general racial/ethnic patterns of cancer in U.S. population subgroups. SEER covers 14% of the total United States population. The SEER data include 78% of the Hawaiian population, 60% of the Japanese population, 49% of the Filipino population, 43% of the Chinese population, 34% of the Korean population, 31% of the Vietnamese population, 27% of the American Indian population, and 25% of the Hispanic population (5).

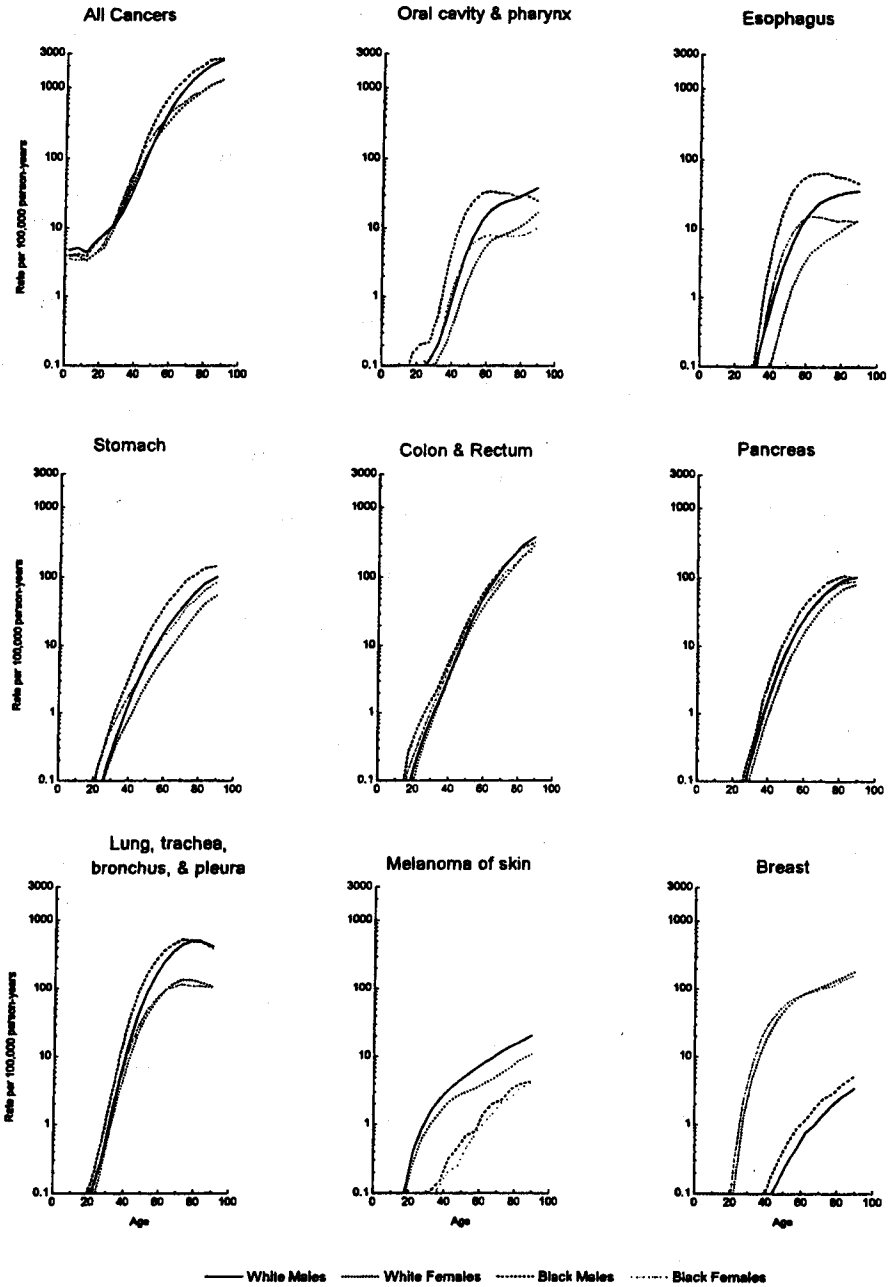


Figure 4 Age-specific mortality rates in the total U.S. for selected cancers by race and sex, 1970-1994.

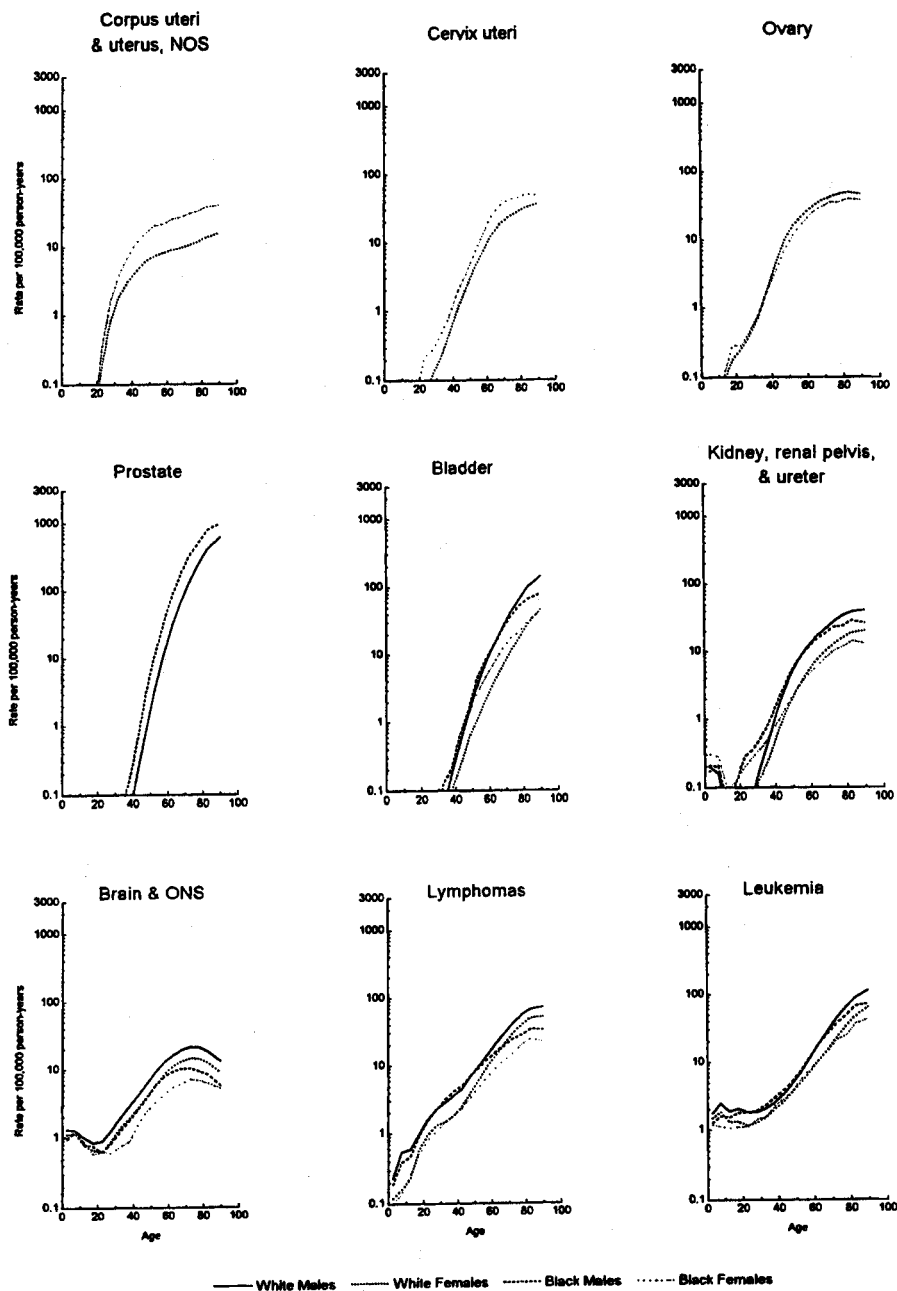


Figure 4 Continued

Table 4 Probabilities (%) of Developing (Ever or After Age 60) or Dying from Cancer by Type of Cancer and Sex: SEER areas, 1992–1994

Type	Males			Females		
	Developing			Developing		
	Ever	After age 60	Dying	Ever	After age 60	Dying
All cancers	46.64	48.46	23.85	38.00	32.75	20.63
Oral cavity and pharynx	1.52	1.22	0.43	0.74	0.60	0.25
Esophagus	0.71	0.68	0.68	0.26	0.24	0.23
Stomach	1.24	1.25	0.80	0.74	0.72	0.52
Colon and rectum	5.88	6.07	2.57	5.72	5.54	2.53
Liver ^a	0.58	0.55	0.56	0.30	0.28	0.33
Pancreas	1.18	1.19	1.11	1.25	1.23	1.21
Larynx	0.77	0.70	0.25	0.18	0.14	0.06
Lung and bronchus	8.43	8.60	7.06	5.55	5.01	4.41
Melanoma	1.46	1.07	0.30	1.07	0.59	0.19
Breast	0.11	0.10	0.03	12.52	9.43	3.46
Cervix uteri	—	—	—	0.83	0.39	0.27
Corpus uteri	—	—	—	2.66	2.17	0.51
Ovary	—	—	—	1.76	1.28	1.14
Prostate	18.85	21.19	3.64	—	—	—
Testis	0.35	0.02	0.02	—	—	—
Urinary bladder ^b	3.38	3.53	0.70	1.18	1.13	0.35
Kidney and renal pelvis	1.29	1.15	0.51	0.83	0.69	0.33
Brain and other nervous system	0.66	0.44	0.51	0.53	0.35	0.39
Thyroid	0.27	0.15	0.04	0.66	0.24	0.07
Hodgkin's disease	0.24	0.08	0.06	0.21	0.07	0.05
Lymphomas	1.96	1.55	0.93	1.68	1.43	0.87
Multiple myeloma	0.62	0.63	0.48	0.55	0.51	0.42
Leukemias	1.35	1.22	0.94	1.03	0.87	0.74

—, not applicable.

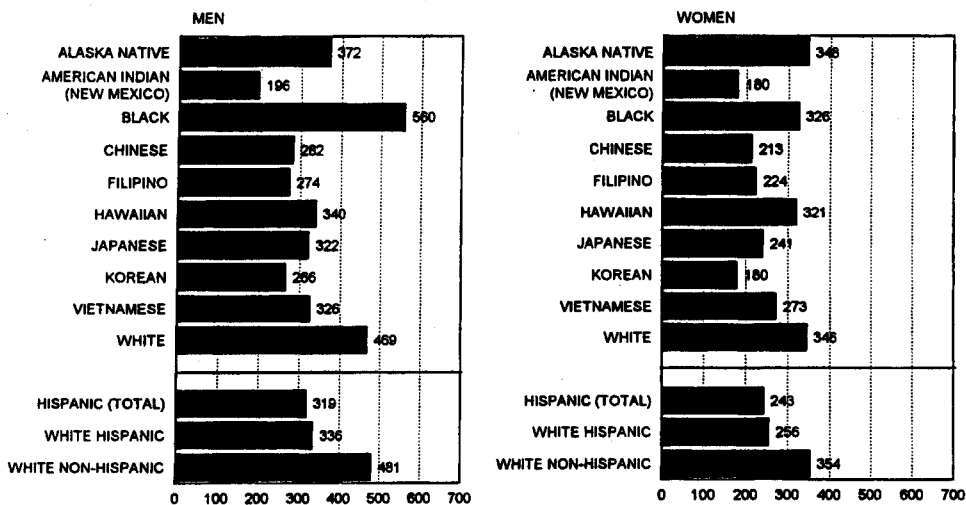
^a Liver and intrahepatic bile duct.^b Urinary bladder (invasive and in situ).

Note: Invasive cancer only unless specified otherwise

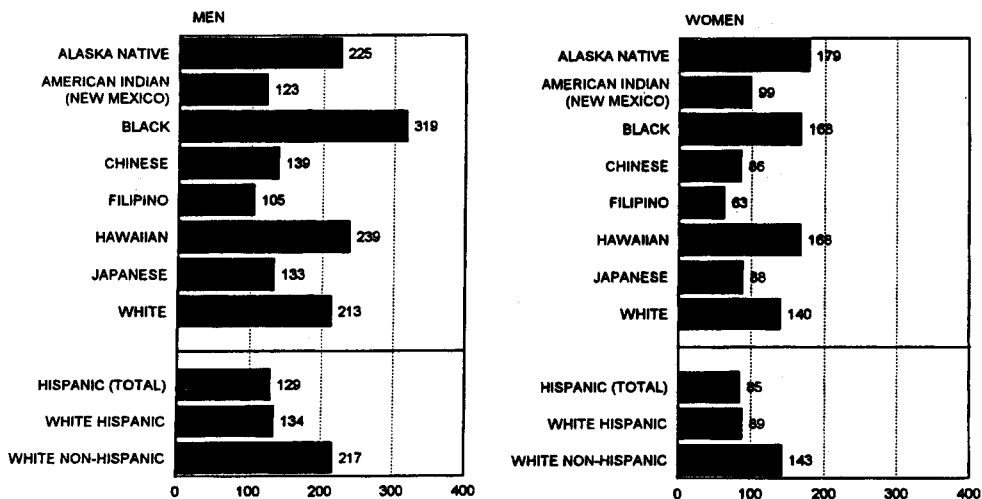
Source: Ref. 1.

American Indian, black, Chinese, Filipino, Hawaiian, Japanese, Korean, Vietnamese, and white are mutually exclusive. The ethnic category Hispanic may include any race; rates are also shown for white Hispanics and white non-Hispanics. Among males, the highest total cancer incidence rates per 100,000 person-years during 1988–1992 occurred among blacks, followed by white non-Hispanics, with relatively low rates among Asian/Pacific Islander populations; these patterns were due

SEER Incidence Rates, 1988-1992



U.S. Mortality Rates, 1988-1992



NOTE: Rates are "average annual" per 100,000 population, age-adjusted to 1970 U.S. standard; N/A = information not available.

Figure 5 Racial/ethnic variation in SEER incidence and United States mortality rates (per 100,000 person-years) for all cancers combined, 1998-1992. (From Ref. 5.)

largely to differences in the incidence of prostate, lung, and colorectal cancers. Incidence rates for prostate cancer were highest among blacks (181), white non-Hispanics (138), and white Hispanics (93), with low rates being observed among the Vietnamese (40) and Koreans (24). Lung cancer incidence rates among males ranged from highs of 117 among blacks, 89 among Hawaiians, 81 among Alaska Natives, and 79 among white non-Hispanics to lows of 44 among white Hispanics, 43 among Japanese, and 14 among American Indians (data for the latter only for New Mexico). Colorectal cancer rates were highest among Alaska Natives (80), Japanese (64), blacks (61), and white non-Hispanics (58) and lowest among American Indians (19). Black males also had relatively high rates of oral (20), esophageal (15), pancreatic (14), and laryngeal (13) cancers and multiple myeloma (11).

Among females, white non-Hispanics had the highest total cancer incidence rate, followed by Alaska Natives and blacks, with the lowest rates being among American Indians and Koreans. Differences in the incidence of breast, lung, and colorectal cancers largely account for these patterns. Female breast cancer incidence rates ranged from highs of 116 among white non-Hispanics, 106 among Hawaiians, 95 among blacks, and 74 among white Hispanics to lows of 32 among American Indians and 29 among Koreans. The highest female lung cancer incidence rates occurred among Alaska Natives (51), blacks (44), white non-Hispanics (44), and Hawaiians (43), with low rates among Filipinos (18), Koreans (16), and Japanese (15). Colorectal cancer incidence rates were highest among Alaska Natives (67), blacks (46), Japanese (40), white non-Hispanics (39), and lowest among American Indians (15). Cervix uteri cancer incidence rates were highest among the Vietnamese (43) followed by white Hispanics (17), Alaska Natives (16), Koreans (15), and blacks (13), with the lowest rate being among the Japanese (6). Among both males and females, total cancer mortality rates were high among blacks, Hawaiians, and Alaska Natives and relatively low among several of the Asian groups. Among racial/ethnic subgroups, the site-specific cancer distributions for ages 70 years and older were similar to those of their racial/ethnic category for all ages combined.

There is also substantial international variation in cancer mortality rates (6, 20). Table 5a presents age-adjusted (world standard) mortality rates during 1990–1992 for all cancers combined among the elderly, defined as ages 65–84 years. Rates among males ranged from highs in the Netherlands, Italy, England and Wales, Uruguay, and Denmark to lows in Australia, Japan, Sweden, Portugal, and Argentina. Other countries, including the United States, had rates that were intermediate. Among females, rates were highest in Denmark and in England and Wales and were lower in Germany, Canada, the United States, the Netherlands, and Uruguay, with the lowest rates being in Argentina, France, Spain, and Japan. These patterns most likely were influenced by variations in the relative frequency of the various forms of cancer.

For example, among males aged 65–84 years, lung cancer was the most common cause of cancer death in every country shown (Table 5b); rates ranged from greater than 600 in the Netherlands and 500 in England and Wales to less than 300

Table 5a International Variation in Total Cancer Mortality Rates^a Among Elderly Males and Females, Aged 65–84 Years, Selected Countries, 1990–1992

Country	Males	Females
United States	1306.1	754.1
Canada	1356.6	754.6
Argentina	1124.9	631.4
Uruguay	1537.4	758.5
Denmark	1494.6	936.6
France	1431.2	583.6
Germany	1399.5	760.8
Italy	1525.1	673.1
Netherlands	1617.6	724.8
Poland	1433.5	688.6
Portugal	1119.1	567.8
Spain	1317.7	540.8
Sweden	1081.6	692.3
England and Wales	1513.1	860.1
Australia	1280.9	676.1
Japan	1213.8	532.8

^a Per 100,000 person-years, age-adjusted by the direct method to the world population standard.

Source: Ref. 6.

in Japan, Argentina, Portugal, and Sweden. Intestinal cancer mortality rates were highest in Germany followed by England and Wales, with the lowest rates again being in Japan and Argentina. Prostate cancer rates exceeded 100 in all countries except in Japan, where the rate was less than 40; rates were highest in Uruguay, Sweden, Denmark, Australia, and the United States. The patterns for stomach cancer were quite different, with the rate exceeding 250 in Japan, 185 in Portugal, 175 in Poland, and 140 in Italy, in contrast to a rate less than 40 in the United States. Oral cancers were most frequent in France; pancreatic cancer in Japan, Germany, and the Scandinavian countries; and bladder cancer in Italy and Denmark.

Among elderly females, shown in Table 5c, lung cancer was the most frequent form of cancer death only in the United States, England and Wales, Denmark, and Canada; rates ranged from less than 25 in Spain to 180 in the United States. Breast cancer was the most common malignancy in the Netherlands, England and Wales, Denmark, and Uruguay, with rates all exceeding 130, in contrast to a rate of only 21 in Japan. Intestinal cancer was the first-ranked cancer in Germany, Poland, Spain, Portugal, Sweden, and Australia; rates ranged from 70 to 130. Stomach cancer was the leading cancer in Japan, with a rate of almost 100, five times that in the United States. Uterine cancer rates ranged from less than 25 in Japan and Australia to almost

Table 5b International Variation in Mortality Rates* for Selected Cancers Among Elderly Males, Aged 65 to 84 Years, Selected Countries, 1990-1992

Country	Mouth and pharynx	Esophagus	Stomach	Intestines	Pancreas	Lung	Prostate	Bladder
United States	22.4	33.3	39.4	144.7	60.8	460.7	173.5	34.6
Canada	26.2	34.5	57.8	170.7	62.8	466.1	169.5	39.2
Argentina	22.4	58.5	92.4	116.4	NA	250.0	132.8	53.0
Uruguay	31.4	77.0	114.3	129.6	NA	391.2	217.8	65.3
Denmark	22.0	40.7	57.2	197.2	66.8	436.3	198.2	87.5
France	56.2	63.3	68.6	178.0	56.7	322.7	163.9	58.2
Germany	24.8	26.1	122.3	186.2	65.1	378.2	162.2	65.3
Italy	32.4	27.8	143.4	164.1	59.6	453.5	122.0	84.8
Netherlands	16.0	40.3	98.5	165.3	68.1	617.5	171.3	65.3
Poland	27.6	28.9	177.1	127.2	57.3	473.1	105.5	68.9
Portugal	28.0	34.4	186.3	159.7	43.8	194.8	154.3	45.9
Spain	30.5	32.4	116.5	135.5	43.9	351.2	135.1	77.6
Sweden	16.1	22.5	71.1	130.3	70.1	194.1	212.9	36.8
England and Wales	16.7	62.1	109.6	181.9	59.0	511.2	173.5	66.9
Australia	28.2	37.5	58.1	170.5	51.4	353.3	182.0	37.3
Japan	14.9	54.0	266.1	119.8	69.3	288.2	38.4	20.7

NA, not available.

* Per 100,000 person-years, age-adjusted by the direct method to the world population standard.

Source: Ref. 6.

Table 5c International Variation in Mortality Rates^a for Selected Cancers Among Elderly Females, Aged 65–84 Years, Selected Countries, 1990–1992

Country	Stomach	Intestines	Pancreas	Lung	Breast	Uterus	Ovary	Kidney
United States	17.1	91.9	44.1	179.6	118.8	30.8	41.2	13.4
Canada	25.9	110.4	45.5	152.8	126.2	30.6	37.0	13.9
Argentina	35.9	71.3	NA	36.0	116.1	49.5	NA	NA
Uruguay	51.0	109.5	NA	27.4	133.9	50.0	NA	NA
Denmark	29.3	132.4	54.8	161.5	143.0	57.3	59.2	21.1
France	26.4	94.9	31.3	34.7	100.3	34.7	36.6	13.1
Germany	59.4	131.2	45.0	56.4	113.2	41.6	45.8	21.0
Italy	64.7	100.3	37.9	54.6	101.5	35.7	24.4	11.4
Netherlands	36.4	114.2	44.0	59.2	140.2	33.0	53.1	19.1
Poland	63.8	84.3	40.1	64.1	76.3	59.6	NA	NA
Portugal	91.5	97.5	26.1	32.6	82.0	39.4	17.7	6.9
Spain	52.4	79.6	26.6	24.9	77.8	32.6	18.4	8.3
Sweden	33.4	95.4	56.5	64.0	86.4	33.5	44.5	24.6
England and Wales	42.6	113.9	43.0	166.2	144.5	37.3	49.1	12.3
Australia	22.5	107.9	37.7	99.1	100.4	24.7	36.2	17.0
Japan	98.0	70.0	41.1	67.3	20.7	24.5	14.5	6.8

NA, not available.

^a per 100,000 person-years, age-adjusted by the direct method to the world population standard.

Source: Ref. 6.

60 in Poland and Denmark, whereas ovarian cancer rates ranged from less than 20 in Japan, Spain, and Portugal to almost 50 in England and Wales and nearly 60 in Denmark.

Among patients diagnosed with cancer (all forms combined) in the United States, the 5-year relative survival rate, which is adjusted for expected general population mortality, ranged from 41% among black males to 62% among white females (Table 6). These rates were driven by the differing relative frequency of the major forms of cancer with varying survival rates. Survival rates were relatively high among patients diagnosed with cancers of the testis, thyroid, prostate, breast, or corpus uteri or with melanoma. Patients diagnosed with liver, pancreatic, esophageal, or lung cancer fared particularly poorly. Compared with patients of all ages, those diagnosed at ages 65 years or older fared better in a few instances, such as those diagnosed with breast cancer, but more frequently they did less well. Differences were substantial for those diagnosed with cervix uteri, corpus uteri, ovarian, or especially brain cancer, Hodgkin's disease, or leukemia. Across the board, survival rates were higher among whites than blacks for most cancers. Black males diagnosed with oral cancer experienced survival rates notably lower than the other three race/sex groups; however, black males with brain or other nervous system cancers had better survival experiences than the other three race/sex groups.

The stage of disease at diagnosis varied considerably among the various solid

Table 6 Five-Year Relative Survival Rates (%) by Race, Sex, and Cancer: All Ages, Ages 65+, SEER Program, 1986-1993

Type	All ages				Ages 65+			
	WM	WF	BM	BF	WM	WF	BM	BF
All cancers	56.5	62.3	41.1	47.9	58.6	54.6	45.7	39.3
Oral cavity and pharynx	51.8	61.7	28.4	47.3	53.1	54.8	25.9	32.8
Esophagus	12.1	11.1	7.5	8.8	10.3	9.3	8.4	7.4
Stomach	16.6	24.5	16.9	25.2	17.5	22.9	15.7	22.8
Colon and rectum	62.9	61.8	51.5	53.2	63.5	61.0	49.3	49.2
Liver	4.4	9.1	3.0	6.6	2.1	4.5	2.1	0.0
Pancreas	3.6	3.9	4.5	5.7	2.0	2.7	3.0	3.3
Larynx	70.5	63.6	53.0	58.7	69.3	58.8	56.5	62.5
Lung	12.7	16.1	10.5	12.2	11.1	14.0	9.3	8.1
Melanoma of the skin	85.4	91.1	50.0	78.7	86.5	86.0	NA	71.0
Breast	-	85.5	-	70.0	-	87.7	-	73.0
Cervix uteri	-	71.4	-	57.1	-	50.6	-	50.0
Corpus uteri	-	85.9	-	55.3	-	82.1	-	44.2
Ovary	-	46.5	-	41.9	-	29.1	-	24.1
Prostate	90.2	-	75.3	-	90.9	-	74.7	-
Testis	95.3	-	86.4	-	88.3	-	NA	-
Bladder	85.1	75.1	65.0	53.6	82.1	69.7	56.8	51.2
Kidney	60.8	58.4	54.0	57.2	56.5	49.4	47.1	41.1
Brain and other nervous system	28.6	30.2	37.6	30.9	3.9	5.4	13.1	6.5
Thyroid	92.9	96.2	87.9	88.9	80.3	80.1	NA	60.4
Hodgkin's disease	79.1	85.2	71.7	75.3	44.0	47.6	NA	NA
Non-Hodgkin's lymphoma	48.7	56.6	40.0	49.0	46.3	47.8	38.1	38.7
Multiple myeloma	29.4	27.3	29.9	30.3	23.3	23.3	25.4	27.4
Leukemias	43.8	41.4	31.4	35.7	35.5	34.7	23.6	25.0

WM, white male; WF, white female; BM, black male; BF, black female; NA, not available; -, not applicable.

Source: Ref. 1.

tumors (Table 7). More than 70% of the cancers were still localized to the organ of origin for those arising in the corpus uteri or bladder and for melanomas of the skin. In contrast, about half of patients diagnosed with ovarian and nearly half of those diagnosed with lung or pancreatic cancer had distant spread of the disease. The stage of disease at diagnosis strongly influenced subsequent survival. Among females diagnosed with cervix uteri cancer, the 5-year relative survival rate exceeded 90% if the cancer was still localized, but it was less than 10% if there was distant spread; the comparable rates for females with breast cancer were 97 versus 21% and for males with prostate cancer, 100 versus 31%.

Table 7 Stage Distribution and 5-Year Relative Survival Rates (%) by Stage of Cancer (All Races, Ages, Both Sexes) for Localized, Regional, Distant Disease, SEER Program, 1986–1993

Type	Stage distribution (%)			5-Year relative survival (%)		
	Local	Regional	Distant	Local	Regional	Distant
Oral cavity and pharynx	36	43	9	80.9	41.8	17.9
Esophagus	24	24	26	22.7	10.4	1.6
Stomach	19	31	36	60.5	22.7	2.2
Colon and rectum	37	37	20	91.6	63.8	7.3
Liver	20	22	24	13.1	6.8	1.8
Pancreas	8	23	48	14.6	5.1	1.5
Larynx	49	32	13	84.6	54.7	41.6
Lung	15	25	45	48.5	18.2	1.9
Melanoma of the skin	82	8	4	95.0	60.8	15.9
Breast	60	31	6	96.8	75.9	20.6
Cervix uteri	52	33	8	91.3	49.4	9.1
Corpus uteri	73	13	9	95.5	66.1	26.8
Ovary	24	13	57	92.6	54.7	25.3
Prostate	58	18	11	100.0	94.1	30.9
Testis	66	19	12	98.5	97.1	72.3
Bladder	74	18	3	93.5	49.0	5.9
Kidney	46	23	24	87.9	59.7	9.1
Thyroid	60	31	5	99.7	93.7	44.8

Source: Ref. 1.

III. HEALTH BEHAVIORS AND RISK FACTORS

Changes in screening practices and lifestyle behaviors impact cancer incidence and mortality. For example, the use of screening procedures to detect early lesions is very important. The large declines in incidence and mortality rates for cancer of the cervix uteri were due largely to the widespread use of the Papanicolaou (Pap) smear and pelvic examination, leading to the increased detection of premalignant treatable lesions (21). Despite its widespread use, older women often go unscreened (22). In recent years, mammography screening has become more prevalent (Table 8) (23). The proportion of non-Hispanic white women aged 50–64 years who had a mammogram within the past 2 years increased from 34% in 1987 to 68% by 1994, a doubling in mammographic participation. Rates among non-Hispanic black and Hispanic women were somewhat lower but also rose substantially, showing increases of 146–161% during this period. Utilization rates among women aged 65 years and older were also somewhat lower than for women aged 50–64 years, but the use of mam-

Table 8 Trends in Mammography Utilization by Age Group, Racial/Ethnic Group, and Socioeconomic Group: Percentage of Women 50 Years of Age and Older Having a Mammogram in the Last 2 Years

	1987	1990	1994
Ages 50–64 years			
Racial/ethnic group			
White, non-Hispanic	33.6	58.1	67.5
Black, non-Hispanic	26.4	48.4	63.6
Hispanic	23.0	47.5	60.1
Ages 65 years and older			
Racial/ethnic group			
White, non-Hispanic	24.0	43.8	54.9
Black, non-Hispanic	14.1	39.7	61.0
Hispanic	13.7 ^a	41.1	48.0
Poverty status			
Below	13.4	28.0	40.3
At or above	25.0	46.6	58.4
Education			
Less than 12 years	16.5	33.0	45.6
12 years	25.9	47.5	59.1
13 years or more	32.3	56.7	64.3

^a Relative standard error greater than 30%.

Source: Ref. 23.

mography increased 129% in white non-Hispanic women, 336% in black non-Hispanic women, and 243% in Hispanic women. Both poverty status and educational level influenced the mammography utilization rate.

Cigarette smoking is the dominant cause of lung cancer (24). It also increases the risk for cancers of the larynx, oral cavity, esophagus, bladder, pancreas, and cervix uteri. The prevalence of cigarette smoking in 1965 exceeded 50% among adult males and 30% of females (Table 9) (23). Since then, the prevalence of current smoking has declined to one-third or less among males and one-quarter or less among females. At each point in time, the prevalence was higher among black than white males, with small racial differences among females. Among persons aged 65 years and older, the smoking prevalence was lower than among the corresponding age range 18 years and older. The prevalence declined consistently over time among males, whereas rates rose among females before peaking during the mid-1980s. During 1994, the prevalence of cigarette smoking among black males was more than twice that among the other three race/sex groups aged 65 years and older.

Although specific dietary factors are less well established as influencing cancer risk, high fruit and vegetable consumption appears to be protective for many cancers,

Table 9 Trends in Cigarette Smoking Prevalence in the United States by Sex and Race: Ages 18 Years and Older, and 65 Years and Older

	1965	1974	1985	1994
Ages 18 years and older				
White males	50.8	41.7	31.3	27.5
Black males	59.2	54.0	39.9	33.5
White females	34.3	32.3	28.3	24.3
Black females	32.1	35.9	30.7	21.1
Ages 65 years and older				
White males	27.7	24.3	18.9	11.9
Black males	36.4	29.7	27.7	25.6
White females	9.8	12.3	13.3	11.1
Black females	7.1	8.9	14.5	13.6

Source: Ref. 23.

whereas high fat consumption may increase the risk of breast, colon, and prostate cancer (25–27). Obesity has been associated with several cancers, including those of the corpus uteri and breast in postmenopausal women. Since the early 1960s, the proportion of the population that was overweight has increased, with the most dramatic increases occurring in the 1988–1994 period (Table 10) (23). At each point in time, the proportion overweight was higher among black females than the three other race/sex groups, and in recent years it exceeded 50%. The percentage overweight tended to increase with age before peaking around age 65 years. In addition, heredity, past reproductive experiences in women, and the cumulative effects of environmental exposures to carcinogenic agents and chemicals in genetically susceptible individuals contribute to the risk of developing cancer.

IV. FUTURE CHANGES IN TRENDS

The burden of cancer in the elderly will progressively increase in the early part of the 21st century owing to the large number of cancers that will be diagnosed as the Baby Boom generation becomes the elderly population in America. One in five persons in the United States will be age 65 years or older by the year 2030, which is a nearly two-fold increase from the 1990 level. A large segment will be from racial and ethnic subgroups. With increased longevity, a greater proportion of these cancers will occur in men.

Reducing the burden of cancer is a challenge. Cumulative effects over time of risk factors, genetic susceptibility, environmental exposures to carcinogens, and less healthy behaviors or practices increase the risk of cancer. However, several

Table 10 Trends in % of Population Ages 20 Years and Older Overweight According to Sex, Race, and Age, United States

	1960–1962	1971–1974	1976–1980	1988–1994
Race/sex group				
White males	23.1	23.8	24.2	34.3
Black males	22.2	24.3	25.7	34.0
White females	23.5	24.0	24.4	33.9
Black females	41.7	42.9	44.3	53.0
Sex/age group				
Males (years)				
20–34	19.6	19.2	17.3	25.4
35–44	22.8	29.4	28.9	34.9
45–54	28.1	27.6	31.0	37.7
55–64	26.9	24.8	28.1	43.7
65–74	21.8	23.0	25.2	42.9
75 and older	NA	NA	NA	27.7
Females (years)^a				
20–34	13.2	14.8	16.8	25.6
35–44	24.1	27.3	27.0	36.8
45–54	30.7	32.3	32.5	45.4
55–64	43.2	38.5	37.0	48.2
65–74	42.9	38.0	38.4	42.3
75 and older	NA	NA	NA	35.1

NA, not available.

^a Excludes pregnant women.

Source: Ref. 23.

factors are likely to have a major effect on reducing the rates of cancer—including the reduction of smoking and increased consumption of fruits and vegetables. Behavioral change interventions to modify lifestyle habits—e.g., smoking, diet—and improved preventive health practices can impact cancer rates. Cancer is a disease of genetic alterations. Technological advancements in genetics research will make possible the identification of individuals at risk for cancer and will influence future trends in cancer incidence and mortality. Advancements in chemoprevention, such as in the tamoxifen prevention study that demonstrated a reduction in the incidence of breast cancer in high-risk women by 45% (28), herald a new era in the primary prevention of cancer.

The paradigm of cancer in the elderly population is changing and will continue to shift over the next few decades. Recent data show that overall cancer incidence and mortality rates are decreasing—a most encouraging sign (29). Compared to an increasing cancer incidence trend during 1973–1990, the rates show an overall decrease on average of 0.7% per year during 1990–1995, most notably for cancers of

the lung, prostate, colon and rectum, and urinary bladder and for leukemia, with a leveling off for breast cancer. Declines in the incidence rates in the elderly were most striking for persons over 75 years of age. Cancer death rates overall, which had increased 0.4% per year during 1973–1990, show a decline on average of 0.5% per year during 1990–1995. Continued monitoring of trends in cancer incidence and mortality will be needed in order to determine changes in the burden of cancer due to differences in cohorts, risk factors, environmental exposures, and lifestyle habits, as well as the effects of genetic screening and early detection in the aging population.

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REFERENCES

1. Ries LAG, Kosary CL, Hankey BF, Miller BA, Hurray A, Edwards BK, eds. SEER Cancer Statistics Review, 1973–1994, National Cancer Institute. NIH Pub. No. 97–2789, Bethesda, MD, 1997.
2. Polednak AP. Projected numbers of cancers diagnosed in the US elderly population, 1990 through 2030. *Am J Public Health* 1994; 84:1313–1316.
3. U.S. Bureau of the Census. Current Population Reports, Special Studies, P23–190, 65+ in the United States. US Government Printing Office, Washington, DC, 1996.
4. Parker SL, Tong T, Bolden S, Wingo PA. Cancer statistics, 1997. *CA Cancer J Clin* 1997; 47:5–27.
5. Miller BA, Kolonel LN, Bernstein L, Young Jr. JL, Swanson GM, West D, Key CR, Liff JM, Glover CS, Alexander GA, eds. Racial/ethnic patterns of cancer in the United States 1988–92, National Cancer Institute. NIH Pub. No. 96-4104, Bethesda, MD, 1996.
6. Levi F, La Vecchia C, Lucchini F, Negri E. Worldwide trends in cancer mortality in the elderly, 1955–1992. *Eur J Cancer* 1996; 32A:652–672.
7. Population projections of the United States by age, sex, race and Hispanic origin: 1992 to 2050. Current Population Reports, Series P-25, No. 1092. US Bureau of the Census, Washington, DC. 1992.
8. Chu TM. Prostate-specific antigen and early detection of prostate cancer. *Tumour Biol* 1997; 18:123–134.
9. Arcangeli CG, Ornstein DK, Keetch DW, Andriole GL. Prostate-specific antigen as a screening test for prostate cancer. The United States experience. *Urol Clin North Am* 1997; 24:299–306.
10. Gann PH. Interpreting recent trends in prostate cancer incidence and mortality (editorial). *Epidemiology* 1997; 8:117–120.
11. Merrill RM, Potosky AL, Feuer EJ. Changing trends in U. S. prostate cancer incidence rates. *J Natl Cancer Inst* 1996; 88:1683–1685.

12. Stephenson RA, Stanford JL. Population-based prostate cancer trends in the United States: patterns of change in the era of prostate-specific antigen. *World J Urol* 1997; 15:331-335.
13. US Department of Health and Human Services. Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General, US Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, US Government Printing Office DHHS Publication No. (CDC) 89-8411, Washington, DC. 1989.
14. McCredie M. Bladder and kidney cancers. *Cancer Surv* 1994; 19-20:343-368.
15. Boyle P. Cancer, cigarette smoking and premature death in Europe: a review including the Recommendations of European Cancer Experts Consensus Meeting, Helsinki, October, 1996. *Lung Cancer* 1997; 17:1-60.
16. Devesa SS, Fears T. Non-Hodgkin's lymphoma time trends: United States and international data. *Cancer Res* 1992; 52:5432S-5440S.
17. Hartege P, Devesa SS, Fraumeni JF Jr. Hodgkin's and non-Hodgkin's lymphomas. *Cancer Surv* 1994; 19-20:423-453.
18. Cerhan JR. New epidemiologic leads in the etiology of non-Hodgkin's lymphoma in the elderly: the role of blood transfusion and diet. *Biomed Pharmacother* 1997; 51:200-207.
19. Travis WD, Lubin J, Ries L, Devesa S. United States lung carcinoma incidence trends: declining for most histologic types among males, increasing among females. *Cancer* 1996; 77:2464-2470.
20. Doll R, Fraumeni JF Jr, Muir CS, eds. Trends in cancer incidence and mortality. *Cancer Surv* 1994; 19-20:1-583.
21. National Institutes of Health Consensus Development Conference statement on cervical cancer. *Gynecol Oncol* 1997; 66:351-361.
22. Martin LM, Calle EG, Wingo PA, Heath CW Jr. Comparison of mammography and Pap test use from the 1987 and 1992 National Health Interview Surveys: are we closing the gaps? *Am J Prev Med* 1996; 12:82-90.
23. USDHHS. Health, United States 1996-97 and Injury Chartbook. DHHS Pub. No. (PHS) 97-1232. National Center for Health Statistics, Hyattsville, MD. 1997.
24. Shopland DR. Tobacco use and its contribution to early cancer mortality with a special emphasis on cigarette smoking. *Environ Health Perspect* 1995; 103(Suppl 8):131-142.
25. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer prevention: a review. *J Am Diet Assoc* 1996; 96:1027-1039.
26. Willett WC. Diet, nutrition, and avoidable cancer. *Environ Health Perspect* 1995; 103(Suppl. 8):165-170.
27. Wynder EL, Cohen LA, Muscat JE, Winters B, Dwyer JT, Blackburn G. Breast cancer: weighing the evidence for a promoting role of dietary fat. *J Natl Cancer Inst* 1997; 89: 766-775.
28. Klausner RD. Breast Cancer Prevention Trial. Statement before the Senate Appropriations Subcommittee on Labor, Health, Human Services and Related Agencies, April 21, 1998.
29. Wingo PA, Ries LA, Rosenberg HM, Miller DS, Edwards BK. Cancer incidence and mortality, 1973-1995, a report card for the U.S. *Cancer* 1998; 82:1197-1207.